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Configuration of the four parasympathetic ganglia of the head

Abstract

The ciliary, pterygopalatine, submandibular, and otic ganglia lie in the head and they are parasympathetic in function. Each has sensory, sympathetic and parasympathetic roots. However, the otic ganglion has an additional motor root. Branches of the ciliary ganglion are named the short ciliary nerves while those of the pterygopalatine ganglion are termed the orbital, pharyngeal, palatine and nasopalatine nerves. On the other hand, branches of the submandibular and otic ganglia are unnamed. The pterygopalatine ganglion is sometimes clinically referred to as the "ganglion of hay fever".

Keywords: parasympathetic ganglia, ciliary, pterygopalatine, submandibular, otic

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Introduction

The four parasympathetic ganglia of the head are related to three out of the four cranial nerves that have parasympathetic activities: the oculomotor (III), the facial (VII) and the glossopharyngeal (IX) nerves. These ganglia include the ciliary, the pterygopalatine, the submandibular, and the otic ganglia. There is a general plan for the configuration of these ganglia. Each ganglion is suspended from a branch of the trigeminal (V) nerve. Each has three roots: sensory, sympathetic and parasympathetic; the otic ganglion, in addition, has a fourth motor root. The cell bodies of the sensory root lie in the trigeminal (Gasserian) ganglion, those of the sympathetic root lie in the superior cervical sympathetic ganglion, and the cell bodies of the parasympathetic root lie in one of three parasympathetic nuclei in the brainstem. The parasympathetic root relays within the ganglion; so it is formed of preganglionic fibers whereas the sympathetic root does not relay, as its fibers are postganglionic. Furthermore, the sensory root runs through the ganglion, without a relay, in a direction opposite to that of each of the parasympathetic and sympathetic roots. The sympathetic root is derived from a plexus around either of the external or internal carotid arteries. After receiving roots, each parasympathetic ganglion gives branches that contain the three types of the received fibers: sensory, sympathetic and parasympathetic.

The ciliary ganglion

The ciliary ganglion lies close to the medial wall of the orbit. It is suspended, by a sensory root, from the nasocciliary nerve that is a branch of the ophthalmic nerve (the 1st division of the trigeminal ganglion). The ciliary ganglion receives its sympathetic root from the plexus around the ophthalmic artery, which in turn is derived from the internal carotid artery plexus. The parasympathetic root for the ciliary ganglion arises, in the midbrain, from the Edinger-Westphal nucleus of the oculomotor (III) nerve, passes through this nerve to its inferior division then to the nerve to the inferior oblique muscle of the eye that gives the parasympathetic root.

The branches of the ciliary ganglion, named the "short ciliary nerves", pierce the eyeball around the optic nerve. Their parasympathetic component fibers supply two intraocular muscles: the constrictor (sphincter) pupillae and ciliary muscles. The sensory fibers in the short ciliary nerves carry sensations from the conjunctiva and cornea (corneal reflex) while the sympathetic fibers supply the ocular blood vessels. It is worthy to note that sympathetic fibers going to the dilator pupillae muscle are found to come directly through the long ciliary branches of the nasocciliary nerve.

The pterygopalatine ganglion

The pterygopalatine ganglion lies in the pterygopalatine fossa. Two sensory roots suspend it from the maxillary nerve that is the second division of the trigeminal ganglion. The sympathetic root is the "deep petrosal nerve" that arises from the internal carotid artery plexus inside the carotid canal, emerges at the apex of the petrous temporal bone, and crosses on the foramen lacerum where it meets the parasympathetic root. The parasympathetic root arises, in the pons, from the superior salivary nucleus of the facial (VII) nerve. It is enclosed within the nervous intermedius part of the facial nerve, to reach the geniculate ganglion of this nerve that gives rise to the "greater superficial petrosal nerve". The latter emerges from the petrous temporal bone through the hiatus and groove for greater superficial petrosal nerve to meet the deep petrosal nerve on foramen lacerum. The two roots (greater and deep petrosal) unite to form the Vidian nerve "nerve to pterygoid canal" that passes through the pterygoid canal to enter the pterygopalatine fossa and to join the ganglion from behind.

The branches of the pterygopalatine ganglion include the orbital branches that pass forwards through the inferior orbital fissure, the pharyngeal branch that passes backwards through the pharyngeal (palatinovaginal) canal, the greater and lesser palatine nerves that descend through their canals, and the short and long nasopalatine nerves that pass medially through the sphenopalatine foramen. Eventually, these branches supply the orbital periosteum, the lacrimal gland, the roof of nasopharynx, the hard and soft palates, and the nose. In hay fever, irritation of this ganglion leads to running nose and eyes.

The submandibular ganglion

The submandibular ganglion lies, in the submandibular region, on the hyoglossus muscle with the deep part and duct of the submandibular salivary gland as well as the hypoglossal nerve situated below it; all deep to mylohyoid muscle. Sensory roots from the lingual nerve suspend the ganglion. The lingual nerve is a branch of the posterior

division of the mandibular nerve that is the third and largest division of the trigeminal ganglion. The sympathetic root for this ganglion comes from the facial artery plexus that is derived from the external carotid artery plexus. The parasympathetic root for the ganglion arises from the superior salivary nucleus of facial (VII) nerve in the pons, runs through the "chorda tympani" branch of facial nerve that escapes from the tympanic cavity through the petrotympanic fissure into the infra temporal fossa, to join the lingual nerve deep to the lateral pterygoid muscle. Unnamed branches originating from the submandibular ganglion either go directly to supply the submandibular salivary gland or rejoin the lingual nerve to supply the sublingual salivary gland and to carry taste sensation from the anterior two-thirds of the mucous membrane of the tongue.

The otic ganglion

The otic ganglion hangs from the medial (deep) aspect of the main trunk of the mandibular division of the trigeminal nerve, and both structures lie deep to the lateral pterygoid muscle in the infratemporal fossa. The sympathetic root for this ganglion comes from the plexus around the middle meningeal artery that is a branch of the first part of the maxillary artery. This plexus originates from the external carotid artery plexus. The inferior salivary nucleus in the medulla oblongata gives rise to the parasympathetic fibers of the glossopharyngeal (IX) nerve that gives its tympanic branch (Jacobson's nerve) that shares in the formation of the tympanic plexus, which gives rise to the lesser superficial petrosal nerve. The latter nerve emerges from the hiatus and groove for the lesser superficial petrosal nerve (in the petrous temporal bone), descends through foramen ovule of the skull to join the otic ganglion as its parasympathetic root. The otic ganglion has an additional motor root that arises from the nerve to the medial pterygoid muscle, passes through the ganglion without relay, and then emerges to supply tensor palati and tensor tympani muscles. Unnamed branches of the otic ganglion join the two roots of the auriculotemporal nerve to supply the parotid gland. The remaining cranial nerve that has parasympathetic function is the vagus (X) nerve. It is related to none of the above-mentioned four parasympathetic ganglia of the head. Its ganglia are terminal close to or within the walls of the respiratory organs, the heart, and the proximal part of the digestive tract.

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Conflict of interest

Author declares that there is no conflict of interest.

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